

**APPRAISAL ASSESSMENT OF THE BLACK ROCK ALTERNATIVE
A COMPONENT OF
YAKIMA RIVER BASIN WATER STORAGE FEASIBILITY STUDY**

Executive Summary

Further Consultations

This appraisal assessment is limited to certain engineering and technical aspects of the potential Black Rock alternative. Furthermore, the information available at this time is necessarily preliminary, has been developed only to an appraisal level of detail, and is therefore subject to change if this alternative is investigated further in the course of the Yakima River Basin Storage Feasibility Study (Storage Study). Finally, economic, financial, environmental, cultural, and social evaluations of the Black Rock alternative have not yet been conducted, and this appraisal assessment offers no conclusions in this regard.

The policy of the Bureau of Reclamation (Reclamation) requires non-Federal parties to share the costs of financing feasibility studies and the eventual construction of Federal reclamation projects. In light of this policy, the preliminary cost estimates presented in this Summary Report, and current Federal budgetary constraints, Reclamation is not reaching a decision at this time as to whether the Black Rock alternative will be carried forward into the next phase of the Storage Study or dropped from further consideration. Rather, Reclamation will consult with the State of Washington (which is cost sharing in the Storage Study), the Yakama Nation, the potential water exchange participants, project proponents, and other interested parties before making a decision in this regard. It is anticipated that a decision will be reached by the fall of 2005.

If the Congress provides further funding for the Storage Study, all technically viable alternatives would be compared and an alternative(s) selected for further analyses in the feasibility phase. (Whether the Columbia River-Yakima River water exchange concept in the form of the Black Rock alternative is included will depend upon whether Reclamation, after these additional consultations, decides to carry that alternative forward into the plan formulation phase of the Storage Study.) The selected alternative(s) would then be subject to detailed evaluation in the feasibility phase in terms of engineering, economic, and environmental considerations, and cultural and social acceptability. This feasibility phase would be the last phase of the Storage Study. Preparation of the Feasibility Report/Environmental Impact Statement would be a part of this final phase.

Preliminary Conclusion on Technical Viability

Reclamation concludes that, based on current information, a potential Columbia River-Yakima River water exchange by means of the Black Rock alternative appears to be technically viable. Reclamation also concludes that a potential water exchange could meet the purposes of the

Yakima River Basin Water Storage Feasibility Study (Storage Study). These conclusions are based on Reclamation's assessment of the following:

- potential participants who may be willing to exchange water;
- availability of Columbia River water in excess of seasonal instream flow targets;
- Washington State water appropriation statutes and exchange participants' water rights and water service contracts;
- damsite and reservoir basin geologic and hydrogeology characteristics; and
- potential facility options and preliminary plans to divert, store, and deliver exchange water
- exchanging Columbia River water for some Yakima River water currently diverted for use in the lower Yakima Valley will significantly improve the reliability of the Yakima River basin's water supply.

Background

In February 2003, Congress authorized the Secretary of the Interior, acting through Reclamation, to conduct the Storage Study. The Storage Study is an ongoing evaluation of options for additional water storage facilities to improve water supplies for the Yakima River basin. It investigates the potential for in-basin storage opportunities (such as Bumping Lake enlargement, a new Wymer dam and reservoir, and a Keechelus to Kachess pipeline) as well as a potential transbasin diversion from the Columbia River (the Black Rock alternative).

One purpose of the Storage Study is to develop additional stored water and manage it to improve anadromous fish habitat. To this end, the water supply goal is to restore the flow regime of the Yakima and Naches Rivers to some semblance of the natural (unregulated) hydrograph. A second purpose is to improve the reliability of the Yakima Project water supply to provide not less than 70 percent supply for junior (proratable) water rights in dry years. Another purpose is to meet growth demand for municipal water supply.

Because the Federal authorization includes the provisions, "...with emphasis on the feasibility of storage of Columbia River water in the potential Black Rock Reservoir", and because the State of Washington appropriated \$4 million in the 2003 legislative session, also instructing that initial study emphasis be on the Black Rock alternative, the appraisal assessment of the Black Rock alternative (Assessment) was undertaken as an early component of the Storage Study. This Assessment focuses on the technical viability of the Black Rock alternative and the potential of a water exchange to meet the Storage Study purposes.

Summary Report

The *Summary Report, Appraisal Assessment of the Black Rock Alternative* (Summary Report) merges into a single document the information and findings of numerous technical reports prepared for this Assessment. The Summary Report also identifies some technical issues involved with the Black Rock alternative that will need to be addressed, and it sets the framework for further analyses. The individual Reclamation reports will be published as a part

of a technical series on the Storage Study website http://www.usbr.gov/pn/programs/storage_study/index.html at, or near, the time the Summary Report is released.

The Summary Report does not quantify annual benefits that may be realized from a potential Black Rock alternative. Work on estimating unit benefit values has begun, but final estimates and the annual benefits have yet to be determined. As a consequence, a benefit-cost analysis has not been prepared, and this Summary Report does not address whether the Black Rock alternative is economically justified. Likewise, a cost allocation to reimbursable and nonreimbursable project purposes has not been made, and an analysis of the ability to repay the reimbursable costs has yet to be done. Further, environmental, social, and cultural impacts have yet to be evaluated.

Black Rock Alternative

The Black Rock alternative concept is to pump water from the Columbia River, when available in excess of current instream flow targets, for storage in a Black Rock reservoir. Stored water would be released to an outflow conveyance system running to the west to the lower Yakima Valley and provided to some lower Yakima Valley irrigation entities situated to receive exchange water into their existing, or modified, distribution systems. The Yakima River water currently used by the potential participating exchange irrigation entities would not be diverted by those entities (and is referred to in this report as freed-up Yakima River water) and would instead be used to meet the Storage Study goals. Other Yakima Valley irrigators with junior proratable water rights, but not physically located to receive exchange water from the Black Rock alternative, would also benefit in dry years by receiving a portion of the freed-up Yakima River water.

A basic requirement of the Black Rock alternative is that a sufficient number of lower Yakima Valley irrigation entities are willing to participate in a water exchange. The following five entities [whose April through October senior (nonproratable) and junior irrigation water rights total 869,000 acre-feet] are identified as potential water exchange participants: Roza and Sunnyside Divisions; and the Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts.

A water exchange with these five irrigation entities could free up about 869,000 acre-feet of Yakima River water in wet and average water supply years for instream flow purposes. In dry years such as 1994 and 2001, this exchange could only free up about 552,000 acre-feet of water, 248,000 acre-feet to firm up the supply of junior irrigation water right holders (those not physically located to receive exchange water) to not less than 70 percent of their rights, and to provide about 304,000 acre-feet for instream flows. The municipal water supply of 30,000 acre-feet would also have to be provided in dry years. Exchange participants' junior irrigation water rights would also be firmed up to not less than a 70-percent supply from Black Rock reservoir. This appears to be the maximum exchange possible.

The Black Rock alternative would involve numerous facilities that could be configured in different ways. This Assessment considered multiple options of the following major facilities between the Columbia River and the intersection of State Highway 24 and Roza Canal mile post (MP) 22.6:

- Two inflow conveyance system options: an all tunnel option and a tunnel/pipeline option, extending from the intake pumping plant discharge to a Black Rock reservoir.
- Three dam options:
 - a rockfill embankment dam that relies on an upstream concrete face as the impervious element,
 - a rockfill embankment dam with an earthen central core of relatively impervious soils,
 - a roller compacted concrete dam made of no-slump concrete placed by earth-moving equipment and compacted by vibrating rollers.
- Two Black Rock powerplant options (a 1,500-cfs, 38-MW powerplant and a 900-cfs, 23-MW powerplant) at the Black Rock outlet facility located adjacent to Roza Canal MP 22.6.

In addition, delivery system options were developed to convey exchange water upstream from Roza Canal MP 22.6 to Roza Division's service area and to the Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts, and downstream from Roza Canal MP 22.6 to Sunnyside Division's Sunnyside Canal. Roza Division's service area downstream from Roza Canal MP 22.6 can be provided exchange water without constructing new delivery systems.

Three preliminary project configurations of major facilities to pump, store, and deliver Columbia River water to Roza Canal MP 22.6 are:

- A large reservoir pump only option includes a fish screened intake from Priest Rapids Lake, a 3,500-cfs pumping plant to lift water to Black Rock Valley, a dam to store 1,300,000 acre-feet of active storage in a Black Rock reservoir, a 2,500-cfs reservoir outflow conveyance system, and powerplants at points of discharge.
- A large reservoir pump/generation option is similar to the large reservoir pump only option, except it includes a multilevel intake to selectively withdraw water from a Black Rock reservoir for a 3,500-cfs powerplant to generate electricity, and a 3,500-cfs tailrace channel to return water back to Priest Rapids Lake.
- A small reservoir pump only option includes a fish screened intake from Priest Rapids Lake, a 6,000-cfs pumping plant to lift water to Black Rock Valley, a dam to store 800,000 acre-feet of active storage in a Black Rock reservoir, a 2,500-cfs reservoir outflow conveyance system, and powerplants at points of discharge.

Table ES-1 shows the characteristics of these three preliminary Black Rock configurations.

Table ES-1. Summary of major facilities for three preliminary Black Rock alternative configurations

OPTIONS →		LARGE RESERVOIR		SMALL RESERVOIR
		PUMP ONLY	PUMP/ GENERATION	PUMP ONLY
FACILITIES				
Priest Rapids Lake intake and fish screen				
	design flow capacity	3,500 cfs		6,000 cfs
	intake location	on right bank of Priest Rapids Lake		
Priest Rapids plant		pumping	pump/generation	pumping
	design flow capacity	3,500 cfs		6,000 cfs
	500-cfs, two-stage spiral case pumps	three		n.a.
	1,000-cfs, two-stage spiral case pumps	two		six
	turbines	n.a.	two 1,750-cfs turbines with 150-MW generators	n.a.
Inflow conveyance system				
	design flow capacity	3,500 cfs		6,000 cfs
	conveyance type	all tunnel		
	inlet/outlet structure	n.a.	multi-level screened	n.a.
Black Rock dam				
	location	original Washington Infrastructure Services' damsite		
	concrete face rockfill embankment dam			
	crest elevation	1790.0 feet		1722.0 feet
	structural height	760 feet		692 feet
	crest width	40 feet		
	central core rockfill embankment dam			
	crest elevation	1785.0 feet		1717.0 feet
	structural height	755 feet		687 feet
	crest width	40 feet		
	spillway	none		
	low-level outlet works:	upstream steel-lined concrete conduit, downstream buried steel pipe, and two jet flow gates in left abutment		
Black Rock reservoir				
	maximum water surface elevation	1778.0 feet		1712.0 feet
	active storage capacity	1,300,000 acre-feet		800,000 acre-feet
	elevation top of active storage	1775.0 feet		1707.0 feet
	inactive storage capacity	157,610 acre-feet		
	elevation top of inactive storage	1500.0 feet		
State Highway 24 relocation		relocated south of Black Rock reservoir in Rattlesnake Hills		
Outflow conveyance system				
	design flow capacity	2,500 cfs		
	intake structure	single-level screened		
	conveyance type	tunnel/pipeline		
Black Rock outlet facility				
	location	adjacent to Roza Canal MP 22.6		
	pump delivery	all water through powerplant to Roza Canal		
		1,500-cfs Black Rock powerplant – 38 MW		
	pressure delivery	upstream bifurcation to pressurized pipeline		
		900-cfs Black Rock powerplant – 23 MW		
Sunnyside powerplant and bypass				
	powerplant capacity	900 cfs – 15 to 29.5 MW		

Technical Issues Needing Further Analyses

There are two technical issues regarding the Black Rock alternative that require further investigation. The results of these investigations could affect the technical viability, cost, and acceptability of the Black Rock alternative.

Seismicity

The initial assessment indicates the Black Rock damsite lies in an area of relatively high earthquake potential. Preliminary seismic hazard analysis suggests a level of ground shaking that might be associated with the occurrence of magnitude 6 to 7+ earthquakes relatively near the site. Because of its proximity to the site, the Black Rock Valley fault appears to be the largest contributor to such an occurrence. While the Black Rock Valley fault has not been studied in sufficient detail to define its activity, it is assumed at this stage of study that the fault may be capable of large-magnitude earthquake. However, Reclamation has determined it is possible to design a potential Black Rock dam that would withstand earthquakes of these magnitudes. Further investigations of the Black Rock Valley fault and the Yakima Fold Belt are needed to guide future engineering design decisions.

Reservoir Basin and Reservoir Rim Leakage

The Pomona Basalt, intercepted at 145 feet deep, appears to be a hydraulic barrier to downward seepage, at least at the site of the initial hydrologic testing. However, if vertical joints and fractures exist in the Pomona Basalt elsewhere in the proposed reservoir basin, significant leakage from the reservoir could occur. Should reservoir leakage reach the geologic units that underlie the Pomona Basalt, there could be significant regional effects on the groundwater system. Future investigations would include hydrologic testing within the reservoir basin to substantiate the hydrologic conditions within the Pomona Basalt and working with the Pacific Northwest National Laboratory to estimate potential leakage and the impact to the Hanford Site. Further investigations are required to characterize the leakage potential of geologic units around the reservoir site.

In addition, current information indicates permeable geologic units may be exposed or covered only by a thin soil layer on the dam abutments and reservoir rim. Depending on the structure and fracturing of these units, significant reservoir leakage could occur. Exploratory drilling is required along the reservoir rim to determine the geologic structure of potential leakage areas. Based on data available to date, it should be possible to accommodate the potential reservoir leakage by various means.

Project Costs

Appraisal-level field construction cost estimates were prepared as a part of this Assessment solely for screening potential facility options and developing preliminary configurations of the Black Rock alternative. These appraisal-level field construction cost estimates are based on available, but limited, data and preliminary designs and drawings and professional assumptions.

Field costs are not the total cost necessary to complete a project. Field construction costs are limited to the costs of construction contracts and do not include costs such as preparing final

engineering designs and specifications, land acquisition, regulatory compliance and permitting activities, environmental mitigation and monitoring, and construction contract administration and management. Thus, total estimated project costs, which have yet to be prepared, would be substantially in excess of estimated field construction costs.

Appraisal-level field construction costs of major facilities to divert, store, and deliver Columbia River water to Roza Canal MP 22.6 are estimated at about \$2.5 to 2.7 billion (June 2004 price levels). Appraisal-level field construction costs to build new facilities or modify existing facilities to deliver exchange water from this point to participants' current facilities are estimated at up to \$270 million, depending on the type of delivery system and amount of a water exchange. Therefore, field construction costs are estimated at about \$2.8 to \$3 billion.

As a rule of thumb in the industry, the additional costs (for preparing final engineering designs and specifications, land acquisition, regulatory compliance and permitting activities, environmental mitigation and monitoring, and construction contract administration and management) are typically estimated to be from 20 to 35 percent of the field construction costs. Based on current information, these appraisal-level field construction cost estimates, and industry-wide, accepted cost estimating methodology, standards, and practices, it is reasonable to anticipate the total construction cost of the Black Rock alternative could be from \$3.5 to \$4 billion.

A more refined cost estimate cannot be provided at this preliminary stage of the study. Furthermore, it is highly likely that this cost estimate will change if the Black Rock alternative is investigated in greater detail.

Additional data should be collected prior to refining potential concepts and project configurations. Value engineering methods of analysis should be applied to identify needs, major cost components, and to reduce overall costs. Value engineering is a problem-solving methodology that examines potential component features of a potential project to determine pertinent functions, governing criteria, and associated costs. Other proposals would then be developed that either meet the necessary requirements at lower costs or that increase the long-term value.

Other Issues to be Addressed

Economic, financial, environmental, cultural, and social aspects have not been addressed in this Assessment. Further investigations and analyses needed to identify and evaluate these issues would be addressed in the next phase of the Storage Study.

In summary, the geologic foundation and hydrologic conditions related to potential reservoir leakage are technical issues requiring further investigations and analyses to guide and refine engineering design decisions. These activities would be addressed in the next phase of the Storage Study. Refined field construction costs and total project costs would be estimated if the Black Rock alternative is investigated in greater detail in the next phase of the Storage Study. It is highly likely this will result in cost estimates different from the preliminary estimates presented in this Summary Report.

